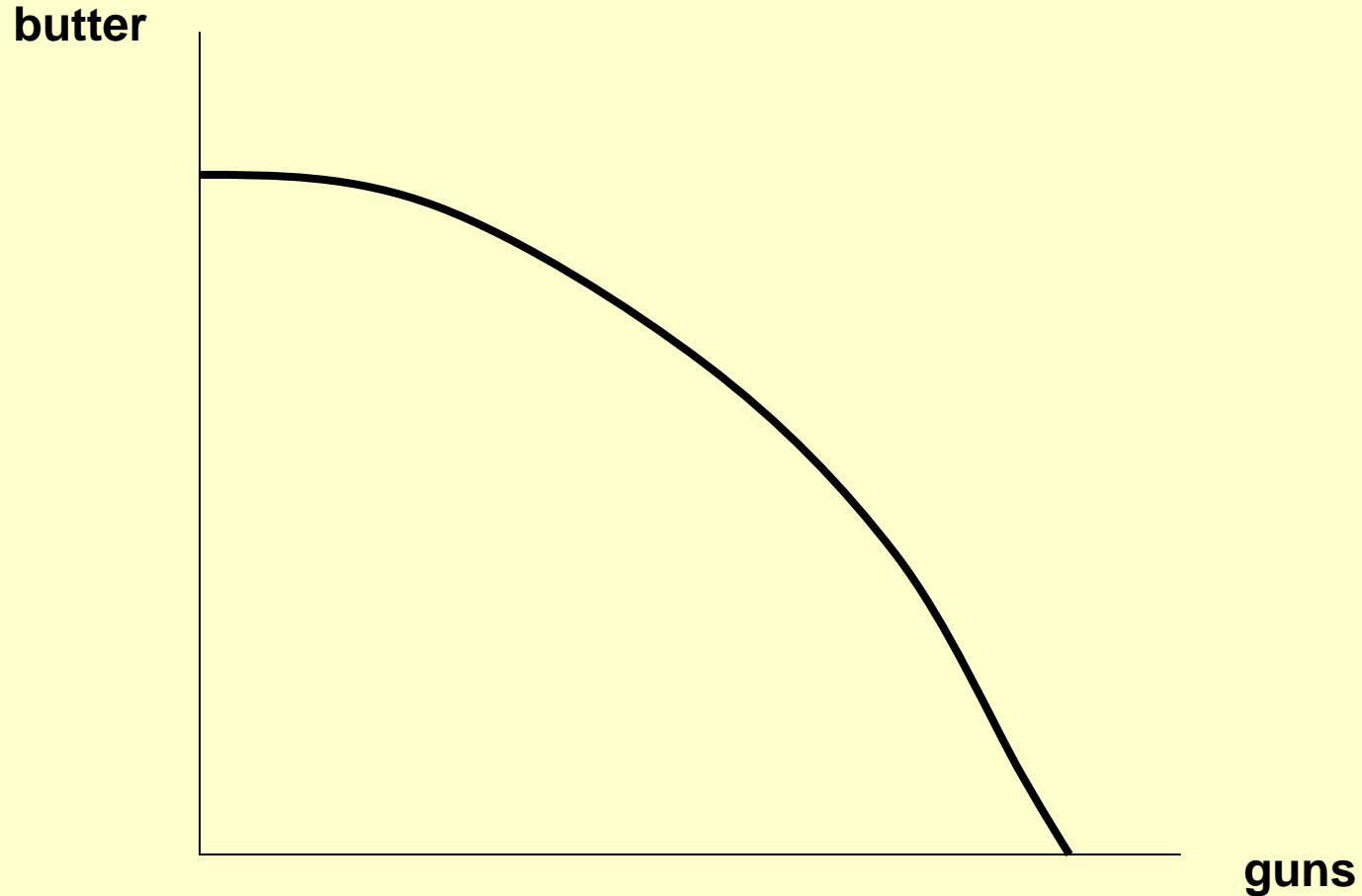# Availability of new drugs and Americans' ability to work
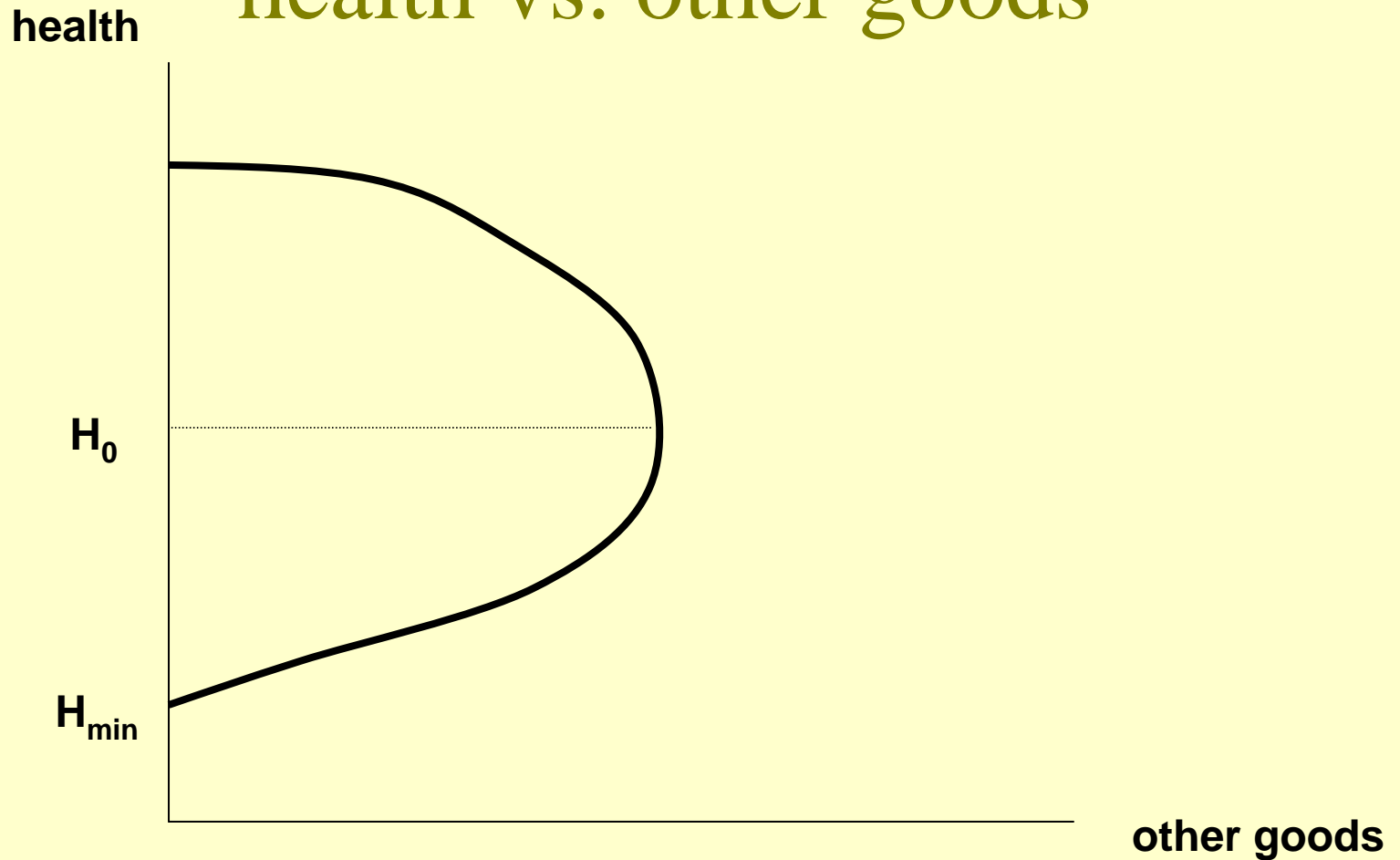
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National Bureau of Economic Research

Standard production possibilities frontier

butter

guns

Production possibilities frontier: health vs. other goods

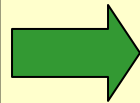**health**

H_0

H_{min}

other goods

Research objectives

- Investigate the extent to which the introduction of new drugs has increased society's ability to produce goods and services, by increasing the number of hours worked per member of the working-age population.

- Attempt to determine whether the value of the increase in goods and services resulting from new drugs exceeds the cost of the drugs.
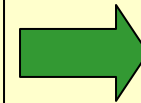
Why are new drugs likely to play an important role in improving health?

- Improvements in health are an important part of economic growth, broadly defined
- Technological progress is the fundamental source of economic growth
- Theory and evidence indicate that productivity growth and technological progress are primarily a result of investment in research and development (R&D)
- The pharmaceutical industry is the most research-intensive industry in the economy

R&D investment → Technological progress → Economic growth
- conventional
- health

Previous evidence re. the impact of new drugs on ability to work

Numerous case studies of specific drugs

- *Terbutaline (approved by the FDA in 1974) for asthma*

- *Glipizide (1984) for diabetes*

- *Sumatriptan and rizatriptan (1992 and 1998, respectively) for migraines.*

However, it is difficult to estimate from case studies the average or aggregate effect of new drugs on ability to work

A new approach

- My analysis is based on data on about 200,000 individuals with 47 major chronic conditions observed throughout a 15-year period (1982-1996).

- Previous studies performed *within-condition* analysis: they compared people with a given condition who were taking a drug to people with the same condition who were not taking the drug.

- I will perform *between-condition* analysis: I will, in effect, examine whether conditions for which many new drugs were introduced exhibited greater increases in ability to work than conditions for which few new drugs were introduced, controlling for other factors.

Outline

- Explain how data from the National Health Interview Survey (NHIS) can be used to measure ability to work, by condition and year.

- Explain how data on the number of drugs previously approved, by condition, year, and "therapeutic potential" (as defined by the FDA) can be constructed using data from several sources.

- Describe a statistical model of the relationship between ability to work, the number of drugs previously approved, and other factors.

- Present estimates of this model

- Discussion

Measuring ability to work, by condition and year

$$\frac{\text{Days worked}}{\text{Working-age pop.}} = \frac{\text{Days worked}}{\text{Employees}} \times \frac{\text{Employees}}{\text{Working-age pop.}}$$

(Biweekly days worked / Working-age pop.) =

(10 – (Days missed/employee)) ×

(100% - % unable to work - % not employed for other reasons)

National Health Interview Survey

- Principal source of information on the health of the civilian noninstitutionalized population of the United States

- Survey remained the same during the period 1982-1996

- During that period, it collected information from 1,017,164 working-age Americans on 133 chronic conditions and impairments

Condition-specific data

- NHIS collected information about:
  - whether each person was unable to work, mainly due to one of the chronic conditions, and
  - the number of work-days missed in the two weeks preceding the interview due to each chronic condition (for currently employed persons)
- Each respondent to the survey was asked about 1/6 of the 133 conditions

- We were able to obtain data on the number of drugs approved for 47 conditions or groups of conditions.
- These 47 conditions account for 75% of all chronic conditions, 57% of chronic conditions causing inability to work, and 50% of work-loss days due to chronic conditions.

Drugs used for treatment of breast cancer, in order of FDA approval

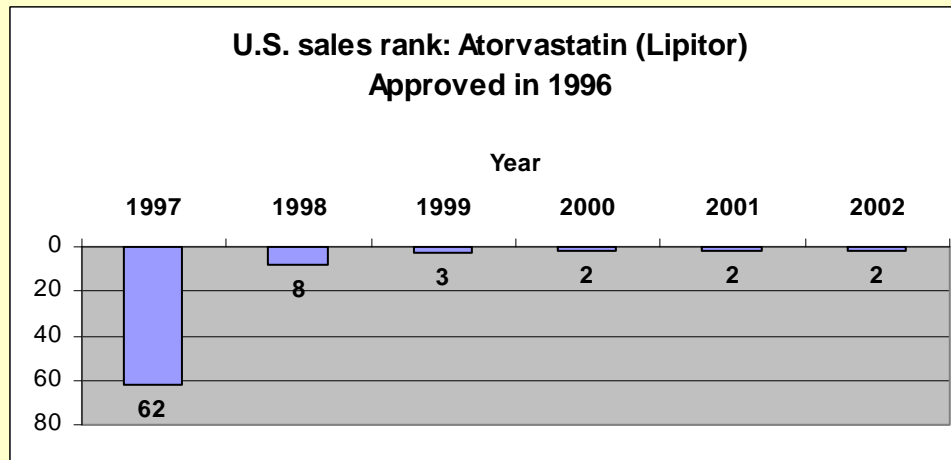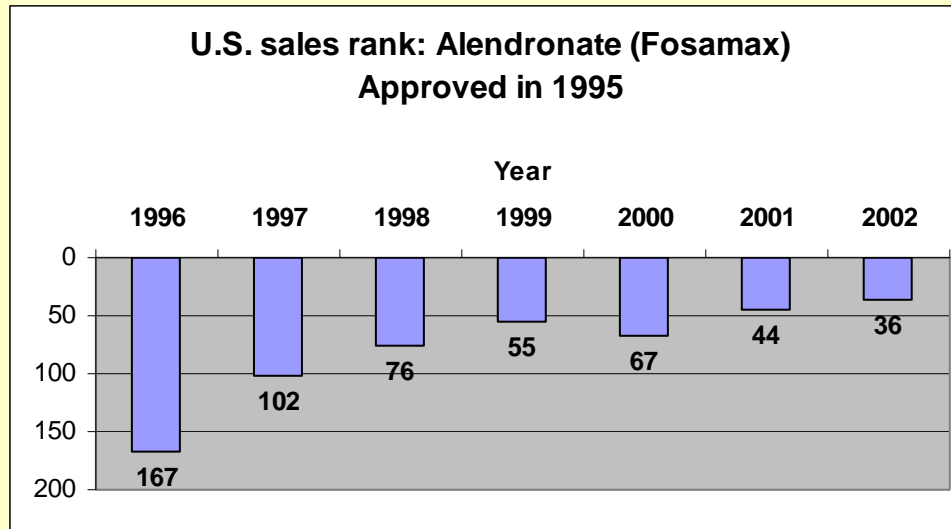| Approval year	Drug	Approval year	Drug
before 1938	Colchicine	1989	Carboplatin
before 1938	Calcitonin	1989	Goserelin
1942	Conjugated Estrogens	1990	Idarubicin
1943	Estradiol, Ethinyl Estradiol	1991	Pamidronate
1953	Methotrexate	1992	Paclitaxel
1955	Diethylstilbestrol, DES	1994	Tamoxifen
1959	Cyclophosphamide	1994	Vinorelbine
1959	Thiotepa	1995	Alendronate
1961	Vinblastine	1995	Anastrozole
1962	Fluorouracil, 5-FU	1995	Daunorubicin Liposomal
1970	Melphalan	1995	Doxorubicin Liposomal
1970	Plicamycin	1996	Docetaxel
1971	Methyltestosterone	1996	Gemcitabine
1974	Doxorubicin	1997	Letrozole
1976	Megestrol	1997	Tiludronate
1977	Esterified Estrogens, Estrone, Estropipate	1997	Toremifene
1977	Etidronate	1998	Capecitabine
1978	Cisplatin	1998	Risedronate
1981	Mitomycin	1998	Trastuzumab
1983	Testosterone	1999	Epirubicin
1984	Vincristine	1999	Exemestane
1985	Leuprolide	2000	Mifepristone, RU-486
1987	Mitoxantrone	2000	Triptorelin
1988	Ifosfamide	2001	Zoledronic Acid

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Figure 4
Cumulative number of drugs approved for three conditions
relative to the cumulative number of drugs approved for that condition in 1975

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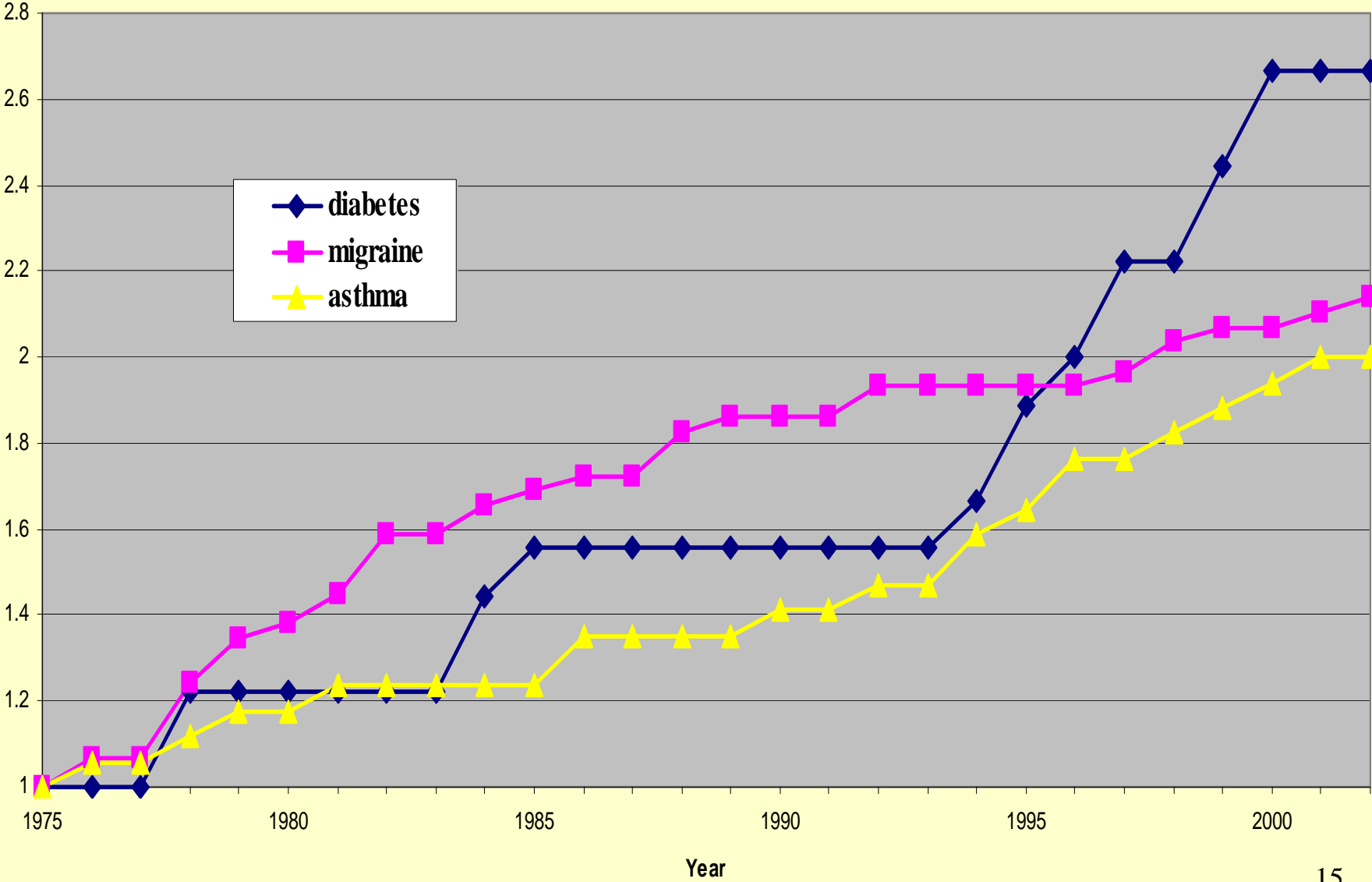
Priority-review vs. standard-review drugs

- "Priority-Review" drugs—those that the FDA believes represent "significant improvements compared to marketed products, in the treatment, diagnosis, or prevention of a disease"

- "Standard-Review" drugs—those that "appear to have therapeutic qualities similar to those of one or more already marketed drugs."

- This classification is probably subject to error, especially since it is made *prior* to the drug's review.

- Estimate two versions of the model: one in which ability to work depends on the total number of previously-approved drugs, and one in which it depends only on the number of previously-approved priority-review drugs.

Gradual diffusion

U.S. sales rank: Alendronate (Fosamax)
Approved in 1995

Year

| 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |

167, 102, 76, 55, 67, 44, 36

U.S. sales rank: Atorvastatin (Lipitor)
Approved in 1996

Year

| 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |

62, 8, 3, 2, 2, 2

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Covariates included

- Gender
- Age
- Race
- Education
- Marital status
- Veteran status
- Region
- Although the demographic factors are highly statistically significant, controlling for them has very little effect on the estimate of the drug coefficient
- This indicates that changes in the demographic distribution of people with a condition have little correlation with changes in the condition's stock of drugs.

Summary of estimates

- Estimates are very consistent with the hypothesis that the probability of being unable to work, limited in work, and having ever been hospitalized, and the number of work-loss days and restricted-activity days, are all inversely related to the stock of drugs (total and/or priority-review) approved 3 to 5 years earlier.

- These estimates enable us to calculate (1) how much the introduction of new drugs reduced the annual rate of growth (or increased the annual rate of decline) of the dependent variables during the sample period, and (2) how much higher inability to work in 1996 would have been absent the post-1982 increase in the lagged stock of drugs.

- The estimates imply that the growth in the lagged stock of all drugs reduced the unconditional probability of being unable to work due to the 47 sample conditions by 1.8% per year during the period 1982-1996.

- I estimate that, if the probability of being unable to work had not been reduced by new drug introductions during 1982-1996, this probability would have been 29% higher in 1996 than it actually was—5.2% instead of 4.0%.

Cost of the new drugs

- MEPS: Average spending on all prescription drugs by people age 18-64 was $255 in 1996.
- Expenditure on drugs approved after 1978 was $116, i.e. just under half of their total drug expenditure.
- The 47 sample chronic conditions account for 44% of total prescription drug expenditure.
- Hence, we estimate that average expenditure on new drugs for the 47 sample chronic conditions per working-age person was $51 (= 44% * $116).
- The estimated benefit of the new drugs, in terms of the value of the increase in workforce participation and hours ($451), is almost nine times as great as the estimated cost of the new drugs.

Reasons for possible underestimation of the impact

- New drugs have probably increased output per hour worked, as well as the number of hours worked.

- We assumed that the social cost of a person's absence from work is the person's wage rate. However if production is team-based, a firm's output is reduced by more than 1% when 1% of its employees are absent.

- New drugs may have reduced morbidity among children and the elderly, and therefore the amount of time working-age people need to devote to caring for them.

Recent study based on state-level data
Conceptual framework

- Use of medical innovations
  - Vintage of Medicaid Rx's
  - Vintage of Medicare drug treatments
- Behavioral risk factors
  - AIDS incidence
  - BMI
  - Smoking
- Health insurance coverage
- Per capita income
- Educational attainment
- Use of other innovations
- State fixed effects
- Year fixed effects
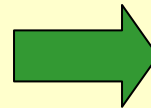
- Life expectancy
  - At birth
  - At age 65
- **Productivity (output per employee)**
- Per capita medical expenditure
  - Total
  - By type of service

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Increase in drug vintage index 1991-2004, by state
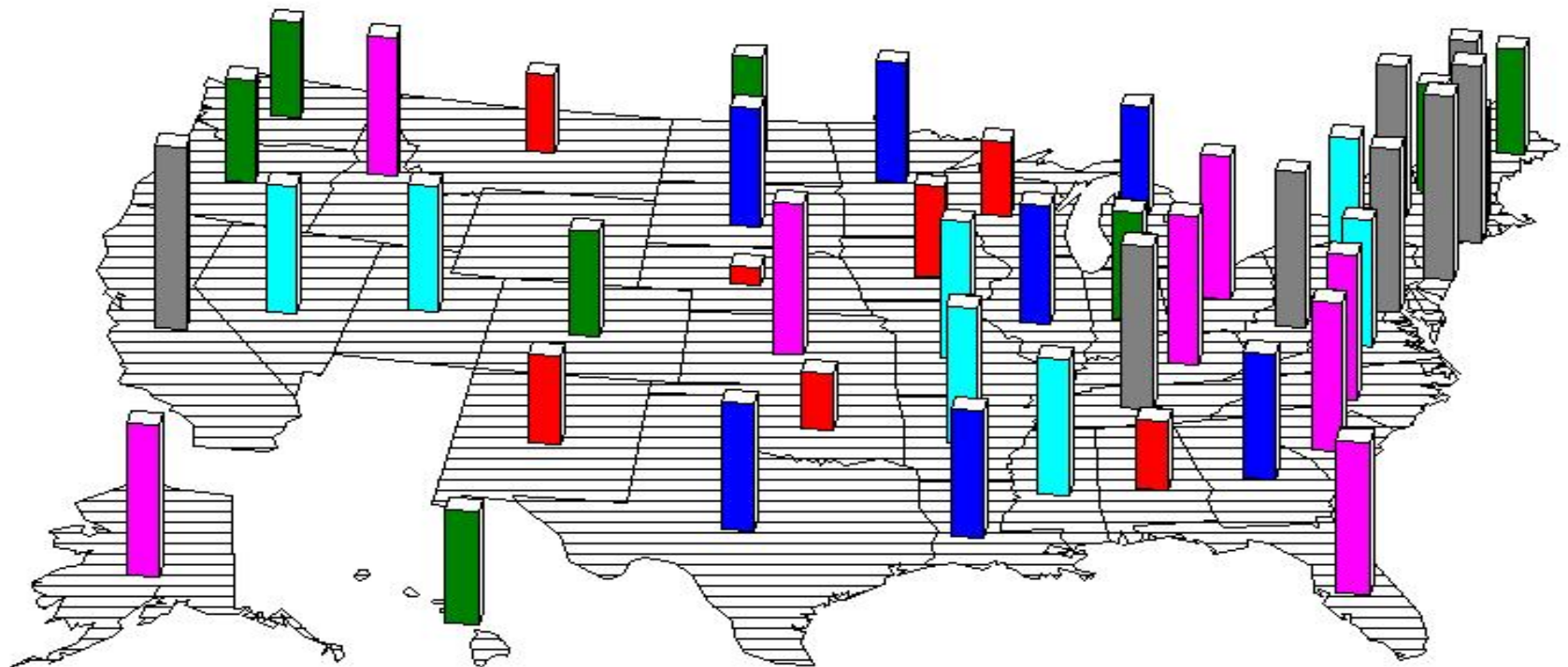
increase in fixed-weighted vintage index, 1991-2004

🟥	7.34495 - 9.87333
🟩	10.21551 - 10.52470
🟦	10.55361 - 10.99557
🟦	11.03476 - 11.47484
🟪	11.58673 - 11.89380
⬜	11.91021 - 13.14684

Productivity estimates

- States with larger increases in Medicaid drug vintage had faster productivity growth, conditional on income growth and the other factors.

- The increase in Medicaid drug vintage is estimated to have increased output per employee by about 1% per year.

- Much of this may be attributable to increased hours worked per employee. Based on a study of disease-level household survey data from the period 1982–1996, Lichtenberg (2005) concluded that pharmaceutical innovation reduced the number of work-loss days per employed person by 1.0% per year.

Concluding remarks

- My analysis does not provide evidence about the merits of any particular drug or even class of drugs.
- But the finding that, overall, new drugs have moved us up along the positively-sloped portion of the production possibilities frontier suggests that policies that broadly reduce the development and utilization of new drugs may ultimately reduce our ability to produce other goods and services.